WHAT IS CLAIMED IS:

1. A signal quality evaluation method for a reproduced equalized signal obtained by reproducing and equalizing a signal recorded on an optical disk medium by using embossing, or by using an optical data recording apparatus, comprising the steps of:

calculating, for each clock cycle, an equalization error between a target signal, which is obtained based on a predetermined data string and a predetermined partial response characteristic, and a signal reproduced each clock cycle; and

evaluating a signal quality based on the auto-correlation of the equalization error.

2. A signal quality evaluation method for a reproduced equalized signal obtained by reproducing and equalizing a signal recorded on an optical disk medium by using embossing, or by using an optical data recording apparatus, comprising the steps of:

projecting an equalization error onto a noise vector that is defined by using a partial response characteristic and a difference between two sets of time series data; and

evaluating a signal quality based on a ratio of the variance of the projected equalization errors to an Euclid distance that is defined by using the partial response characteristic and the difference between the two sets of time series data.

3. An optical disk signal quality evaluation method for a reproduced equalized signal obtained by reproducing and equalizing a signal recorded on an optical disk medium by using embossing, or by using an optical data recording apparatus, comprising the steps of:

designating an equalization error $v_k = (y_k - \Sigma a_{k-i} h_i)$, wherein y_k denotes the value of a signal reproduced and equalized for each clock cycle, a_k

denotes a predetermined data string and h_k denotes a predetermined partial response characteristic, and designating a time delay operator D that uses a clock time as a unit;

designating as a polynomial $A(D) = \Sigma\alpha_j D_j$, which is defined by using α_j, a coefficient of either 1, 0 or -1, and which satisfies $\alpha_j\alpha_{j+1} \neq -1$, and designating $H(D) = \Sigma h_k D_k$ as a PR polynomial that defines a partial response;

based on a polynomial defined as $N(D) = A(D)H(D) = \Sigma\varepsilon_i D_i$, calculating a signal quality evaluation value S that is defined by the following equation (18)

$$S = \frac{N(\sum_i \varepsilon_i^2)^2}{\sum_{k=1}^{N}(\sum_i \varepsilon_i\, v_{k+j})^2}$$

(18); and

evaluating the quality of a signal recorded on an optical disk.

4. A signal quality evaluation method according to claim 3, whereby the quality of the signal recorded on the optical disk is evaluated based on the signal quality evaluation value S obtained for at least two sets in sets of tap coefficients ε_i, one of which is a set of tap coefficients ε that provide the smallest Euclid distance $d = \Sigma\varepsilon_i^2$ and another one of which is a set of tap coefficients ε that provide the second smallest Euclid distance d.

5. A signal quality evaluation method according to claim 3, whereby $h_0 = 1$, $h_1 = 2$, $h_2 = 2$, $h_3 = 2$ and $h_4 = 1$ are used as the partial response characteristic, and the quality of the signal recorded on the optical disk is evaluated based on the signal quality evaluation value S that is obtained for each set of tap coefficients ε that provide an Euclid distance d of 12 or 14.

6. A signal quality evaluation method according to claim 3, whereby $h_0 = 1$, $h_1 = 2$, $h_2 = 2$, $h_3 = 2$ and $h_4 = 1$ are used as the partial response characteristic, and the quality of the signal recorded on the optical disk is evaluated based on the signal quality evaluation value S that is obtained for

each of at least three sets of tap coefficients ε that are represented by the following equation (19).

$$\varepsilon : \varepsilon_0 = 1, \varepsilon_1 = 2, \varepsilon_2 = 2, \varepsilon_3 = 2, \varepsilon_4 = 1$$

$$\varepsilon : \varepsilon_0 = 1, \varepsilon_1 = 2, \varepsilon_2 = 1, \varepsilon_3 = 0, \varepsilon_4 = -1, \varepsilon_5 = -2, \varepsilon_6 = -1$$

$$\varepsilon : \varepsilon_0 = 1, \varepsilon_1 = 2, \varepsilon_2 = 1, \varepsilon_3 = 0, \varepsilon_4 = 0, \varepsilon_5 = 0, \varepsilon_6 = 1, \varepsilon_7 = 2, \varepsilon_8 = 1$$

(19)

7. A signal quality evaluation method according to claim 1, whereby $h_0 = 1$, $h_1 = 2$, $h_2 = 2$, $h_3 = 2$ and $h_4 = 1$ are used as the partial response characteristic and $R_1 = \Sigma v_k v_{k+1}/N$ is determined, wherein v_k denotes an equalization error and N denotes the number of samples; and whereby the quality of the signal recorded on the optical disk is evaluated by examining a first signal quality evaluation value S_1, a second signal quality evaluation value S_2 and a third signal quality evaluation value S_3 that are represented by the following equations (20), (21) and (22).

$$S_1 = \frac{14}{R_0 + (12R_1 + 8R_2 + 4R_3 + R_4)/7}$$

(20)

$$S_2 = \frac{12}{R_0 + (8R_1 + R_2 - 4R_3 - 6R_4 - 4R_5 - R_6)/6}$$

(21)

$$S_3 = \frac{12}{R_0 + (8R_1 + 2R_2 + R_4 + 4R_5 + 6R_6 + 4R_7 + R_8)/6}$$

(22)

8. A signal quality evaluation method according to one of claims 1 to 3, whereby the predetermined data string is binary data for the reproduced equalized signal obtained by a Viterbi decoder.

9. A signal quality evaluation method according to on of claims 3 to 8, whereby the number N of samples is equal to or greater than 10^4.

10. A signal quality evaluation apparatus, for a reproduced equalized signal y_k that is obtained by reproducing and equalizing a signal that

has been recorded in advance on an optical disk medium by using embossing or by using an optical data recording apparatus, comprising:

a target signal generator for generating a target signal $\Sigma a_{k-i} h_i$ based on a predetermined data string a_k and a predetermined partial response characteristic h_k;

a computation unit for using the reproduced equalized signal y_k and the target signal $\Sigma a_{k-i} h_i$ to calculate an equalization error $v_k = (y_k - \Sigma a_{k-i} h_i)$; and

means for using auto-correlation for the equalization error to calculate a quality evaluation value for the reproduced equalized signal y_k.

11. A signal quality evaluation apparatus, for a reproduced equalized signal y_k that is obtained by reproducing and equalizing a signal that has been recorded in advance on an optical disk medium by using embossing or by using an optical data recording apparatus, comprising:

a target signal generator for generating a target signal $\Sigma a_{k-i} h_i$ based on a predetermined data string a_k and a predetermined partial response characteristic h_k;

a computation unit for using the reproduced equalized signal y_k and the target signal $\Sigma a_{k-i} h_i$ to calculate an equalization error $v_k = (y_k - \Sigma a_{k-i} h_i)$;

a delay element group, including a plurality of delay elements, for receiving the equalization error, and for outputting equalization errors v_k, v_{k-1}, . . . and v_{k-n+1} a plurality of times;

means for receiving the equalization errors v_k, v_{k-1}, . . . and v_{k-n+1}, and for calculating R_n ($n = 0, 1, 2, . . .$ to $L - 1$), based on the following equation (23), and outputting R_n;

noise variance calculation means for performing weighting for R_n with a coefficient β_0, β_1, . . . or β_{L-1} to obtain a noise variance $\Sigma \beta_i R_i$; and

quality evaluation value calculation means for using the noise variance $\Sigma \beta_i R_i$ to calculate a quality evaluation value for the reproduced equalized signal.

$R_n = E\{v_k, v_{k-n}\}$, ($E\{x_i, y_i\}$ is the average value of the product x_iy_i)   (23)

       12. A signal quality evaluation apparatus, for a reproduced equalized signal y_k that is obtained by reproducing and equalizing a signal that has been recorded in advance on an optical disk medium by using embossing

5   or by using an optical data recording apparatus, comprising:

       a target signal generator for generating a target signal $\Sigma a_{k-i}h_i$ based on a predetermined data string a_k and a predetermined partial response characteristic ($h_0 = 1$, $h_1 = 2$, $h_2 = 2$, $h_3 = 2$, $h_4 = 1$);

       a computation unit for using the reproduced equalized signal y_k and

10   the target signal $\Sigma a_{k-i}h_i$ to calculate an equalization error $v_k = (y_k - \Sigma a_{k-i}h_i)$;

       a delay element group, including a plurality of delay elements, for receiving the equalization error, and for outputting equalization errors v_k, v_{k-1}, . . . and v_{k-n+1} a plurality of times;

       means for receiving the equalization errors v_k, v_{k-1}, . . . and v_{k-n+1},

15   and for calculating R_n ($n = 0, 1, 2, \ldots$ to $L - 1$), based on the following equation (24), and outputting R_n;

       noise variance calculation means for performing weighting for R_n with a coefficient β_0, β_1, . . . or β_{L-1} to obtain a noise variance $\Sigma\beta_iR_i$; and

       quality evaluation value calculation means for using the noise

20   variance $\Sigma\beta_iR_i$ to calculate a quality evaluation value for the reproduced equalized signal.

$R_n = E\{v_k, v_{k-n}\}$, ($E\{x_i, y_i\}$ is the average value of the product x_iy_i)   (24)

       13. A signal quality evaluation apparatus according to claim 12, wherein the noise variance calculation means calculates a first noise variance

25   σ_1^2 using the coefficients $\beta_0 = 1$, $\beta_1 = 12/7$, $\beta_2 = 8/7$, $\beta_3 = 4/7$ and $\beta_4 = 1/7$, calculates a second noise variance σ_2^2 using the coefficients $\beta_0 = 1$, $\beta_1 = 8/6$, $\beta_2 = 1/6$, $\beta_3 = -4/6$, $\beta_4 = -1$, $\beta_5 = -4/6$ and $\beta_6 = -1/6$, and calculates a third nois variance σ_3^2 using the coefficients $\beta_0 = 1$, $\beta_1 = 8/6$, $\beta_2 = 2/6$, $\beta_3 = 0$, $\beta_4 = 1/6$, $\beta_5 = 4/6$, $\beta_6 = 1$, $\beta_7 = 4/6$ and $\beta_8 = 1/6$; and wherein the quality evaluation value

calculation means calculates the quality evaluation value by using the smallest of the values $(14/\sigma_1^2)$, $(12/\sigma_2^2)$ and $(12/\sigma_3^2)$.

14. An optical disk apparatus on which a quality evaluation apparatus according to one of claims 10 to 13 is mounted.

15. A signal quality evaluation apparatus according to one of claims 10 to 13, wherein the predetermined data string is obtained by performing Viterbi decoding for the reproduced equalized signal.

16. An optical disk, on which data are recorded under a condition wherein the signal quality evaluation value S according to claim 3, or the first signal quality evaluation value S_1, the second signal quality evaluation value S_2 and the third signal quality evaluation value S_3 according to claim 7, are equal to or greater than 12.

17. An optical disk, on which data are recorded under a condition wherein the signal quality evaluation value S according to claim 3, or the first signal quality evaluation value S_1, the second signal quality evaluation value S_2 and the third signal quality evaluation value S_3 according to claim 7, are equal to or greater than 15.

18. An optical disk recording/reproduction apparatus or reproduction apparatus for performing data recording or data reproduction under a condition wherein the signal quality evaluation value S according to claim 3, or the first signal quality evaluation value S_1, the second signal quality evaluation value S_2 and the third signal quality evaluation value S_3 according to claim 7, are equal to or greater than 12.

19. An optical disk recording/reproduction apparatus or reproduction apparatus for performing data recording or data reproduction under a condition wherein the signal quality evaluation value S according to claim 3, or the first signal quality evaluation value S_1, the second signal quality evaluation value S_2 and the third signal quality evaluation value S_3 according to claim 7, are equal to or greater than 15.

20. An optical disk recording/reproduction or reproduction apparatus comprising:

a function for generating a target signal based on the value of a signal reproduced for each clock cycle, a predetermined data string and a predetermined partial response characteristic; and

a function for calculating an equalization error that is the difference between the signal reproduced for each clock cycle and the target signal.

21. An optical disk recording/reproduction or reproduction apparatus according to claim 20, further comprising:

a function for performing addition or multiplication, or a sum of product operation, for equalization errors occurring at different times.

22. An optical disk recording/reproduction or reproduction apparatus according to claim 20 or 21, wherein at least 10^4 equalization errors are obtained through calculation.